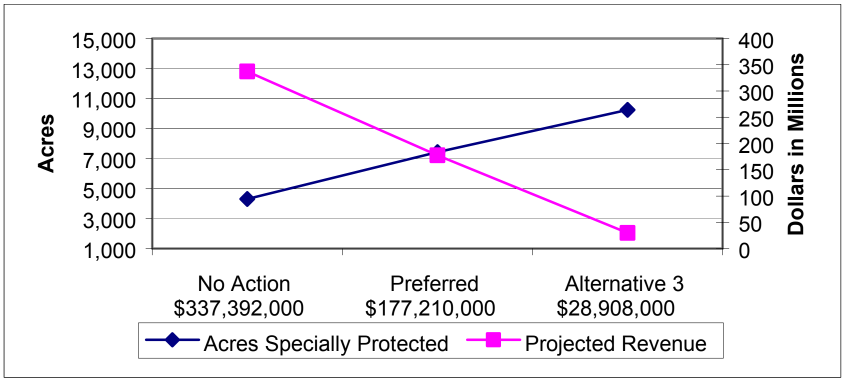
Figure 3: Acres Specially Protected/Projected Revenue



Review of the Affected Environment, Potentially Significant Environmental Impacts, & Mitigation Measures for the Proposed Alternatives

The PDEIS, which was part of the scoping process, discussed known information regarding the affected environment, potentially significant impacts and mitigation measures for five proposed alternatives. The DEIS provides analysis of the affected environment, potentially significant impacts and mitigation measures specific to the three final alternatives, including the preferred alternative developed by DNR and the Committee. This analysis incorporates information and considers concerns raised during the PDEIS public comment process. (The PDEIS, comments and response are available on the Internet at DNR's homepage, http://www.dnr.wa.gov.)

Affected Environment – Existing Conditions

Natural Environment [6]

Earth

Topography and Relief

The Lake Whatcom Landscape Management Planning Area is located in the North Cascades Physiographic Province. It consists of two north-south trending ridges separated by a basin in which Lake Whatcom is located. Lookout Mountain is located west of the lake, Stewart Mountain to the east, and Anderson Mountain to the southeast.

Elevations vary from 307 feet above sea level at the surface of Lake Whatcom to 3,364 feet atop Anderson Mountain, based on US Geological Survey topographic mapping. Ridges on Stewart and Anderson mountains have general elevations of approximately 3,000 feet, while Lookout Mountain is 2,677 feet at the summit.

[6] Each analyst worked independently, often accessing different GIS and other data sources. As a result, percentages and acreages of different forest types and other elements may vary slightly from section to section though the general patterns will be similar and accurate.

The complex topography within the area is explained in detail in the Lake Whatcom PDEIS, pages 91-92. North of Lake Whatcom, and southwest of the lake to an irregular line from Chuckanut Creek on the west to Sudden Valley Golf and County Club on the east, the terrain is relatively gentle with slopes of 20 percent or less. To the south, on Lookout Mountain, and east and northeast of Lake Whatcom the terrain is steeper and more complex, with 30 to 40 percent slopes, truncated by deeply incised stream channels with walls generally inclined more than 50 percent, often 70 percent or steeper. Southeast of Blue Canyon on Stewart Mountain and southeast of Lake Whatcom on Anderson Mountain the terrain consists of complex slopes inclined at 20 to 30 percent, separated by steeper slope areas inclined at up to 80 to 100 percent. Deeply incised channels also truncate this area of the landscape.

Geologic Setting
The planning area is underlain by metasedimentary rock and low-grade metamorphic rock that were deposited as oceanic sediments, recrystallized under heat and pressure, and stacked by thrust faulting (likely subduction) to form what is called the Darrington Phyllite (Lapen, 2000.) Metamorphic rock has been uplifted, eroded and then buried in local basins by coarse-grained sediments, which were subsequently lithified, folded and faulted to form the Chuckanut Formation.

The Puget Sound region has experienced erosion and deposition by glacial processes during the past million years, with the most recent glaciation ending about 10,500 years ago. Glacial processes shaped landforms, including the valley containing Lake Whatcom, Reed and Cain Lakes, as well as the east-west valley extending from Lake Whatcom to Mirror Lake. Glacial erosion exposed the metamorphic rocks from Blue Canyon southward and Reed and Cain lakes eastward. Glacial outwash covers the underlying rock north of Lake Whatcom between Stewart and Squallicum mountains, south in the vicinity of Reed and Cain lakes, and along the floor of the outwash channel between Mirror Lake and the south end of Lake Whatcom.

Soil and Rock Characteristics
Rock Units: Darrington Phyllite, primarily a slope-forming rock unit, is comprised mainly of mica grains in thin, foliated layers and consequently is relatively weak.

The Chuckanut Formation is subdivided into two members, the Padden Member and the Bellingham Bay Member. The Padden Member underlies the gentle topography located north of Chuckanut Creek and Sudden Valley Golf and Country Club. It is comprised of layers of sandstone and conglomerate alternating with mudstone layers.

In the project area, the Bellingham Bay Member underlies and is situated south and east of the Padden Member. The Bellingham Bay member is made up of coarse sandstone, conglomerate and mudstone and forms relatively steeper slopes than the overlying strata. Geology of the Lake Whatcom area is shown on Geology Map 7, PDEIS Appendix C.

Soils: Soils are primarily sand, gravel and non-plastic fines, derived from the weathering of rock and various slope processes. In the area underlain by phyllite the soils consist of fine-grained to sand-sized mica platelets, with occasional larger rock clasts. Soil depths are commonly less than five feet, except for landslide deposits which may be up to 20 or so feet deep. In the area underlain by Chuckanut strata the soils are coarse-grained and consist of sand and sand with gravel. Soil depths range from a few inches on steep slopes (in locations where soil is present) to more than 10 feet in local depressions, slope movement features and in alluvial fans.

Deposits on the valley floors north, south and east of Lake Whatcom range from silt and silty sand to gravel. Organic silt deposits and peat are found along the valley floor between Lake Whatcom and Mirror Lake (US Department of Agriculture, Soil Conservation Service, 1992).

Geologic Processes

Glaciation eroded steep slopes within the planning area, but when glacial ice receded these slopes collapsed. Smaller scale slope processes occur sporadically in response to climatic cycles and land management activities.

Erosion

Streams have eroded deep, steep-walled channels between the ridges and the valley bottoms. During intense, long-duration rainstorms and rain-on-snow events, debris flows can be triggered (Varnes, 1978), collecting debris as they travel down the channel. During intense storms, the flows often reach alluvial fans at the mouth of the channels on the shores of lakes Whatcom, Louise, Reed and Cain. There are residences on several of the fans within areas now classified as Alluvial Fan Hazard Areas under the Whatcom County Critical Areas Ordinance (Title 16, Chapter 16.16.340). Several residential properties situated on alluvial fans were severely damaged by debris flows on January 9 and 10, 1983, when six inches of rainfall fell in Whatcom and Skagit counties and seven to ten inches likely fell on snow at higher elevations. This type of slope movement occurs periodically in the area, based on core sampling of lake sediments (Orme, 1989).

Surface erosion in forested areas is precluded by the lack of overland flow. It occurs only where the duff has been removed along steep channel walls, landslide scarps, roads and log skid trails.

Surficial Geologic Processes – Mass Wasting Mapping Units:

During the 1997 Watershed Analysis, the Lake Whatcom area was subdivided into six mass wasting map units (MWMU), based on landform, slope shape and gradient, slope movement processes, and the likelihood of sediment delivery to fish habitat and other public resources (DNR, Northwest Region, 1977). DNR delineated similar conditions in the remainder of the Planning Area, using the same criteria. MWMUs with designations of “high” and “moderate” potential hazard rating for forest practice activities were then given designations as Areas of Resource Sensitivity (ARS). The MWMUs, ARS designations and slop stability ratings are summarized below:

Summary of Mass Wasting Mapping Units (MWMUs)

MWMU 1A	Ancient and dormant slump-earthflow topography, Low(Stable)
MWMU 1B (ARS 1)	Headscarps and toes of ancient and dormant deep-seated landslides, Moderate (Unstable)
MWMU 1C (ARS 2)	Incised stream channels within deep-seated landslides, High (Unstable)
MWMU 2 (ARS 3)	Incised stream channels and associated landforms in phyllite, High (Unstable)
MWMU 3	Stable slopes (various), Low (Stable)
MWMU 4 (ARS4)	Incised stream channels and associated landforms in Chuckanut Formation, High (Unstable)

Further discussion can be found in Appendix PDEIS-5. The MWMUs are shown on the Water Types and Mass Wasting Map, Map 6, Appendix C of the PDEIS.

Potentially Unstable Slopes

Potentially Unstable Slopes were mapped as part of the landscape planning assessment process, and included slopes steeper than 70 percent in MWMU 1A, MWMU 3, and on slopes adjacent to Cain and Reed lakes.

Terrain Characteristics

Slopes mapped as being "potentially unstable" are areas that were not included in the previously mapped ARSs, have not been subjected to slope movement processes, and indicate a potential for future slope movement. These include slopes inclined steeper than 70 percent, incised stream channels, convergent (concave) headwall areas, slopes at the outside edges of stream meanders, and slopes greater than 65 percent at the toes and scarps of deep-seated landslides.

Slope Movement Processes (Mass Wasting)

No historic mass wasting has occurred within this area.

Erosion

Surface erosion is limited to sites where the forest duff has been removed along road cuts and fills, logging skid trails, landslide scarps and along active stream channels.

Key Elements Affecting Slope Processes

Terrain and Climatic Effects: Key elements are slopes having inclinations greater than 65 percent at the toes and scarps of deep-seated landslides, other slopes with inclinations greater than 70 percent, and ground water pressures during intense, long-duration rainstorms and rain-on-snow events. During periods of high flow, soil is removed from bends along stream channels, undercutting and removing support from the slope.

Human-caused Effects: To date, timber management has had no adverse effects on areas mapped as potentially unstable slopes. Slope movement processes could be triggered if cut slopes steeper than 1.5H:1V (horizontal/vertical) were constructed in soil, or from local concentration of water on soils on steep slopes.

Seismicity

Western Washington is a seismically active area. Low magnitude earthquakes occur nearly every day and at least four earthquakes greater than Richter Magnitude 5.0 have occurred within a 50-mile radius of the site over the last 100 years. Studies by Brian Atwater (1987) conclude that much larger, perhaps greater than magnitude 8.0, subduction-zone earthquakes occur periodically along the Washington coast, the last approximately 300 years ago.

The Uniform Building Code (International Conference of Building Officials, 1997) classifies the area around the Planning Area as a Zone 3 earthquake hazard. The U.S. Geological Survey Earthquake Hazards Program lists a 10 percent probability of occurrence for a probabilistic ground motion value of 23.3 percent of the acceleration of gravity in rock occurring in a 50-year period for the Bellingham area (U.S. Geological Survey, 2001).

AIR

The Lake Whatcom planning area is subject to a maritime climate with cool dry summers and mild wet winters.

The proposal's potential impact on air quality was raised as an issue during scoping. While the proposal is not expected to directly affect this resource, DNR chose to discuss this issue briefly in the PDEIS.

At present, the Air Quality Index indicates the Bellingham area is rated as "Good," the healthiest rating.

Air quality is regulated by the Federal Clean Air Act, which requires the Environmental Protection Agency (EPA) to set National Ambient Air Quality Standards for pollutants considered harmful to public health and the environment. An "air quality standard" is an established concentration, exposure time and frequency of occurrence of one or more air contaminants in the ambient air (surrounding outside air) that is not to be exceeded. Ambient air quality standards have been set for six principal pollutants: carbon monoxide, nitrogen dioxide, ozone, lead, particulate matter and sulfur dioxide.

In Whatcom County, air quality is regulated by the Northwest Air Pollution Control Authority (NWAPA), one of seven regional agencies responsible for enforcing air quality laws in Washington. NWAPA regulates more than 400 sources of air pollution, including outdoor burning permits, and monitors the Air Quality Index. DNR's Smoke Management Plan also provides regulatory direction, operating procedures and advisory information regarding the management of smoke and fuels on the forestlands of Washington State. Its purpose is to coordinate and facilitate the statewide regulation of prescribed outdoor burning on lands protected by DNR and on unimproved, federally managed forestlands and participating tribal lands. The plan is designed to meet the requirements of the Washington Clean Air Act.

Burning

Wildfire

These comments are based on analysis of historical trends in fire use and wildfire occurrence in the general area. None of the three alternatives specifically address prescribed fire use.

The planning area is classified as fire regime 3 (Hardy, 2000). Historically, mixed severity wildfires occurred in the planning area every 35 to 100-plus years. Between 1970 and 2000, seven wildfires occurred on state land in the planning area. Fire causes were: incendiary (1), recreation (2), smokers (1), debris burning (2), and logging (1). The largest fire was 0.8 acres. All other fires were no larger than 0.1 acre.

The potential for damaging wildfires to occur in the planning area depends principally on two factors: the amount and type of human activities that could cause fires, and the accessibility of the area to firefighters to suppress fires while they are small. A summary of the factors affecting water quality of municipal watersheds, including wildfire, is contained in *Municipal Water Supplies from Forest Watersheds in Oregon: Fact Book and Catalog* (Adams and Taratoot, 2001).

Fires, when they do occur, can affect air quality. Fires produce a variety of pollutants, including particulate matter, carbon monoxide, methane, and nitrogen oxides (EPA, 1996). Impacts to the planning area from the release of mercury during wildfires were raised as an issue in response to the PDEIS. A literature search and consultation with air quality specialists revealed that there is very little published work on the emission of mercury from vegetation burning (personal communication, Wickman 2003). One study conducted by Friedli, et. al. (2001: Mercury in smoke from biomass fires. *Geophysics Research Letter*, 28, 3223-3226) found that nearly 100 percent of mercury stored in fuels was emitted to the atmosphere, 95 percent in the form of elemental mercury. The mercury deposited locally is the remaining 5 percent, emitted as particulate mercury. Friedli's work was conducted under controlled laboratory conditions. Actual wildland fires may potentially emit more particulate mercury (Wickman 2003).

Friedli, et. al. found that mercury is emitted from burning vegetation. They projected that mercury emitted from forest fires and from all biomass burning is an important global source of mercury in the atmosphere. Historically the area has experienced very few wildfires. Since significant emissions from wildfires on state lands in the Lake Whatcom watershed are unlikely, it is not likely that wildfires in the area will contribute to mercury levels in Lake Whatcom.

A research project planned to take place over the next three years in the Superior National Forest will measure the mobilization and accumulation of mercury in response to prescribed fire (Kolka, et. al, 2003). See the study plan in DEIS Appendix D.

Silvicultural Burning
No permits for silvicultural burning were issued on state lands in the Planning Area between 1993 and 2001. Very little, if any, silvicultural burning is planned for the Lake Whatcom area under any of the alternatives. Any burning conducted under any of the alternatives would be done in compliance with DNR's Smoke Management Plan, and state and federal clean air regulations.

WATER
Trust lands are a significant source of water flowing into Lake Whatcom. DNR has estimated that 35 percent of the annual inflow volume comes from these lands. See the PDEIS Affected Environment 4.1.1.3 (page 98). Activities on trust lands within the basin have the potential for significantly influencing the quality and quantity of water in Lake Whatcom.

The primary use of trust lands within the Lake Whatcom Landscape Planning Area is commercial forest production. Other uses include or could include special forest products, recreation, mining, oil and gas exploration, and communication sites. However, commercial forestry activities are more pervasive and have the greatest potential to influence water quantity and quality. Therefore the effects of these activities are emphasized in the following discussion.

Surface Water Quality

Surface water quality has been influenced by a variety of land uses within the Lake Whatcom basin. For the purposes of this analysis, only those water quality parameters associated with forest management activities are considered. These include sediment, water temperature, and nutrients. Other surface water quality issues are of concern in Lake Whatcom. However, management of trust lands is not a significant contributor to these problems. See PDEIS Affected Environment 4.1.1.3 (pages 98-99).

Sediment: Sediment yields from streams in the Lake Whatcom planning area are currently above background levels because of past management activities. Estimates of the amount of increase varied between sub-basins. The combined increase from all forested sub-basins in the Lake Whatcom planning area was estimated to be about 2.4 times greater than background levels. Some of the increase is delivered to streams by road runoff. However, most (95 percent) of the increase on a volume basis is attributed to accelerated mass wasting. Over half of this volume is associated with a single event that occurred 20 years ago (January 9-10, 1983). Therefore the majority of annual sediment yields are much lower than the estimated long-term average. The HCP, new Forest Practices Rules and Watershed Analysis prescriptions all are designed to improve fish habitat; some actions under these will have immediate effects while others, particularly those requiring time for trees to grow, will take longer. See PDEIS Affected Environment 4.1.1.3 (page 99) for more information.

Temperature: Approximately 75 percent of forest stream miles within the Lake Whatcom planning area have adequate shading for maintaining surface water temperature standards for Class AA streams. Limited temperature measurements in the recent past have not detected violation of standards. However, more continuous measurements in 1990 found that daily maximum temperatures occasionally exceeded the allowable standard. See PDEIS Affected Environment 4.1.1.3 (pages 99-100).

Nutrients: Nutrient concentrations in forest streams within the Lake Whatcom planning area are quite low in comparison to drinking water quality standards. An exception is Wildwood Creek where nitrogen-fixing red alder is the dominant vegetation within the riparian zone. Concentrations can vary by season and land use condition. Winter concentrations are generally higher for the more soluble compounds such as nitrates because of the decrease in uptake by vegetation. This same effect can occur throughout the year when vegetation is removed. The degree of change can vary with soil conditions and the amount of precipitation. However, numerous studies conducted in the western United States have found that the change is within the range of hundredths or tenths of a milligram per liter when all of a small watershed is harvested (Dissmeyer, 2000).

Forest management activities do not significantly affect concentrations of soluble phosphorus (Dissmeyer, 2000). This has been demonstrated by water quality measurements taken in Lake Whatcom (Matthews *et al.,* 2002). Trust forest lands influence Basin 3. Total phosphorus concentrations have consistently been lower in Basin 3 than in the more urban influenced Basins

1 and 2. At times of peak phosphorous loading, concentrations in Basins 1 and 2 have been as much as 2.5 to 4.5 times greater than those in Basin 3. Most of the less soluble phosphorus entering surface waters is attached to sediment. Therefore those activities that have a potential for increasing surface erosion or mass wasting are the most likely to influence total phosphorus loading. See PDEIS Affected Environment 4.1.1.3 (Pages 100-101) for more information.

Surface Water Quantity
Most of the rainfall and snowmelt in the Lake Whatcom planning area infiltrates into the soil. Water not held in the soil matrix is transported down to aquifers or laterally through the soil until it emerges at springs, seeps, or stream channels. It is estimated that 96 percent of this water is delivered to Lake Whatcom as surface water.

The hydrographs of forest streams follow seasonal precipitation patterns with low flows occurring in the summer and high-flow responses to storm events in the fall and winter. Sometimes storm flows are augmented by snowmelt from higher elevations during relatively warm winter storms. These events are commonly called rain-on-snow, and they are often associated with extreme peak flows.

Annual water production can be increased by timber harvest because of the reduction in evapotranspiration. Usually the increased water production causes more prolonged recession flows and greater responses to early fall precipitation events. Timber harvest can also influence rain-on-snow processes at elevations prone to frequent snow accumulation and warm winter precipitation events (1,700-2,900 feet). The harvest allows greater snow accumulation and faster rates of snowmelt. These influences have the potential to significantly increase peak flows that can change channels and cause flooding depending on the proportion of the watershed area that continues to affect rain-on-snow processes as mature forest stands (hydrologic maturity).

Current levels of hydrologic maturity for sub-basins within the Lake Whatcom planning area are shown in the table below. In addition threshold hydrologic maturity levels are estimated for preventing detrimental increases in peak flows. The threshold estimates are based on the Lake Whatcom Watershed Analysis (DNR, 1997a) and the criterion that the two-year peak flow would not be increased by more than 10 percent.

Table 8: Hydrologic maturity thresholds for Hydrologic Analysis Units within the Lake Whatcom watershed.

HYDROLOGIC ANALYSIS UNIT	CURRENT ACRES OF EFFECTIVE HYDROLOGIC MATURITY	THRESHOLD ACRES OF EFFECTIVE HYDROLOGIC MATURITY	PERCENT OF FORESTED AREA IN THRESHOLD ACRES
Austin Creek	3041	1738	38
Beaver Creek	1432	1134	42
Brannian Creek	1252	800	34
Carpenter Creek	425	188	23
Cub Creek	472	228	48
Fir Creek	532	311	48
Olsen Creek	2181	1286	54
Smith Creek	3008	1744	51

The term “effective hydrologic maturity” was used in Table 8 because the stage of recovery to pre-harvest conditions was considered in determining the current acres. Recovery estimates were based on the results of a study conducted by Hudson (2000) in coastal forests of southwestern British Columbia. In this study, snow courses were measured over five seasons. The snow courses included vegetation conditions ranging from old growth to open sites. Snow accumulation and loss, mainly due to melt, were measured along with tree height and stand density. Hudson found a significant relationship between tree height and recovery in terms of snow accumulation and loss. The recovery curves shown in Figure 4 were produced using these results and a site index table (King, 1966).

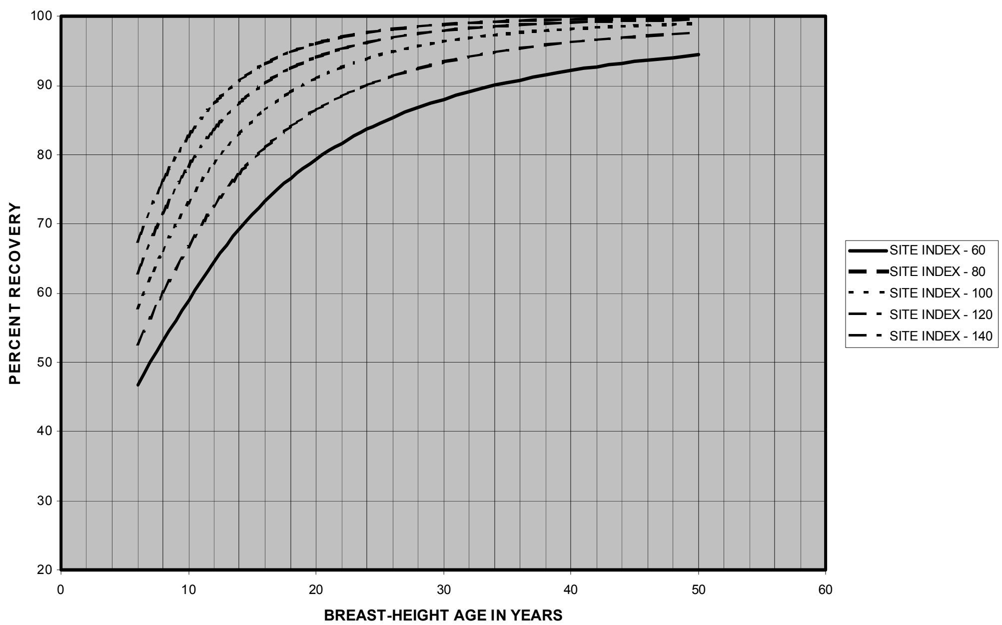


Figure 4. Recovery of hydrologic maturity with stand age by 50-year site index.

See PDEIS Affected Environment 4.1.1.3 (pages 101-102) for more information.

Ground Water Quality
As stated in the PDEIS Affected Environment 4.1.1.3 (page 102), the comments about nutrients and surface water quality also pertain to ground water quality.

Ground Water Quantity
The quantity of ground water is influenced by forest management activities in the same manner as surface water. The only exceptions are localized decreases where disturbance has caused impermeable or semi-impermeable conditions, and overland flow is produced. In most cases the overland flow will return to sub-surface flow or ground water. Therefore the only significant changes are increases in ground water where there has been recent harvesting. See PDEIS Affected Environment 4.1.1.3 (page 103).

Public Water Supply
Lake Whatcom is the municipal water supply for the City of Bellingham and Water District 10. Water is also extracted from Brannian Creek for the Brannian fish hatchery. The relationship

between trust forest land management and these water supplies is discussed in the PDEIS Affected Environment 4.1.1.3 (page 103).

PLANTS AND ANIMALS

Forest Vegetation: Upland, Riparian, Wetland

Conditions in the Lake Whatcom watershed reflect a long history of logging, beginning in the 1870s and 1880s. Approximately 68 percent of the planning unit is forested at present, dominated by western hemlock zone forests in the mid-seral "closed" canopy condition (please see PDEIS pages 106-107 for definitions of stand conditions). Only four percent of the planning unit consists of forests of 100 years or older (See PDEIS page 108 for a complete breakdown of the percentage of the planning area in each age class and stand condition. DNR, in work on the Sustainable Harvest Calculation, has developed a stand structure classification system to describe the forest in terms of stand structure and ecological development to assist with its management of habitat. See DEIS Appendix D for more information.). Dominant tree species are Douglas-fir, Western hemlock and Red alder.

Snag and down wood densities are relatively low in the planning unit, presumably due to historic logging practices that did not leave a legacy of snags and fallen trees.

There are many streams within the planning unit, but wetlands are few due to steep topography. Small wetlands are found within riparian areas and in the uplands, associated with folds in the underlying sandstone.

For more in-depth discussion of existing wetland riparian and forest conditions, see pages 105-109 in the PDEIS.

Forest Health: Insects and Disease

Forest health is Athe condition of a forest being sound in ecological function, sustainable, resilient, and resistant to insects, diseases, fire, and other disturbance, and having the capacity to meet landowner objectives" (RCW 76.06.020). The most serious forest health problems occur when natural forest dynamics are upset and tree resilience is decreased, allowing damage agents to flourish. Forest health targeted activities are undertaken when damage agents are expected to unacceptably impact the management objectives for a specific site or area and a net benefit could be achieved by using targeted forest health practices. Forest health practices include harvest, thinning, salvage, slash treatment, revegetation with more desirable species, hazardous tree removal, and pesticide application.

The major forest health problems observed or expected to occur in the Lake Whatcom area include insects (Douglas-fir beetle, balsam woolly adelgid, hemlock looper, Douglas-fir pole beetle), animals (bear, mountain beaver), disease (root diseases, needle cast), and weather (water, wind, winter damage, and drought). Most are native. The majority of them typically are not active every year, kill a few trees at a time, affect one tree species, or affect one size class of tree. As the forest ages, it becomes more at risk of tree losses to Douglas-fir beetle, western hemlock looper, hemlock dwarf mistletoe, silver fir beetle, decay fungi, and weather-influenced maple decline. Hazardous trees, those likely to fall and damage valuable targets, are also a forest health consideration.

None of these problems currently imminently threatens the watershed as a whole. Some may currently be significant problems on specific sites. Native insects and diseases typically do not threaten ecosystem processes, but do impact specific management objectives. Exotic insects or diseases may threaten ecosystem components.

All of these forest health problems are favored by specific forest structures that can be prevented, mitigated, or eliminated through standard forest management practices. An example of forest management choices involving Douglas-fir beetle activity in windthrown timber is provided in the PDEIS on page 110.

Forest health concepts complement the Lake Whatcom Landscape Plan objectives well because the plan itself guides management priorities and emphasizes the conservation of natural processes. Forest health concepts may come into conflict with the stated objectives and strategies when blanket limitations on certain management activities prohibit what would be prudent actions in response to a specific insect or disease condition. How some objectives interplay with forest health concerns is described in the PDEIS (pages 110-113).

Rare and Sensitive Plants
The only records for rare and sensitive plants in the planning unit are for two populations of Lobelia dortmanna, from the shores of Lake Whatcom in the 1930s and 1960s. L. dortmanna is an aquatic herb, listed as threatened in Washington, whose habitat is sandy substrates in shallow, low nutrient water. All three of the alternatives discussed in this DEIS would tend to slightly reduce nutrient levels in the lake over time, due to the increase of large woody debris in streams, which could act as a sediment barrier. This could potentially be a slight benefit to L. dortmanna, if it in fact still inhabits the lake. Beyond this, it is unlikely that forest practices activities conducted through any of the alternatives discussed in this DEIS would have any impact on L. dortmanna populations.

Animals
Wildlife Species Native to the Area
Many wildlife species use the Lake Whatcom planning area. The bald eagle is the only animal species listed as endangered, threatened or of concern by the U.S. Fish and Wildlife Service (USFWS) that has been documented, and which is likely to still occur, in the Lake Whatcom landscape. There are two known bald eagle nesting territories within the planning area. Other federally listed species that may have occurred historically on the landscape but have likely been extirpated include the northern spotted owl, marbled murrelet, gray wolf, grizzly bear, wolverine, and fisher.

Surveys to Pacific Seabird Group (PSG) protocol have been conducted on potentially suitable marbled murrelet habitat within the planning area, with no murrelet detections. This included 187 acres of potential habitat in 1997-1998, and 459 acres of potential habitat in 2001-2002. The habitat that was surveyed in 2001-2002 was determined to be potentially suitable, according to a predictive model that identified areas expected to contain 95 percent of the occupied murrelet sites on DNR-managed trust lands. A second iteration of the model identified 502 additional acres of potential habitat ("reclassified-plus" habitat) within the Lake Whatcom watershed. This potential habitat is currently deferred from harvest. It is anticipated that small amounts of additional potential habitat may be identified primarily during reconnaissance for future harvest activities.

Other wildlife species of interest that may occur in the Lake Whatcom planning area include the common loon, great blue heron, osprey, northern goshawk, pileated woodpecker, Vaux's swift, purple martin, olive-sided flycatcher, tailed frog, Townsend's big-eared bat, western toad, Keen's myotis, and Yuma myotis. For more information on these species of interest, please refer to the PDEIS, pp. 112-115.

When relevant, potential impacts of the alternatives to the above-listed species of interest are discussed, as well as possible mitigation measures on a species-specific basis. Some wildlife species are addressed as they relate to species groups (e.g., neotropical migratory birds). However, the overriding analysis of impacts to habitat availability focuses on guilds of species that share breeding and feeding habitat preferences (i.e., "life forms"). For more information regarding the life form approach, see the PDEIS (pages 115-116).

Forest Habitats: Quality and Quantity
State lands within the planning area are currently dominated by mid-seral forest stands in the pole/closed seral stages (see Map J-1 – Age Class from FRIS Data in PDEIS Appendices). [See "Forest Vegetation" for a description of the forest age distribution, species and structural character.] Because of this, overall wildlife diversity is likely limited within the landscape, as mid-seral stages of forest development generally support fewer wildlife species than do late-seral stages.

In addition, this landscape is relatively isolated from other forested landscapes. There is little to no connectivity between the forested stands within the planning area and other forested lands adjacent to or beyond it, due to the level of human development surrounding most of it. Beyond the planning area boundaries, there is the city of Bellingham to the northwest, I-5 to the west, and State Highway 9 to the southeast and east. Between the planning area and these roadways, there is considerable rural development and/or private forestlands that are predominantly in early seral stages (0-20 years old). To the east of the planning area is the Samish River drainage, and farther to the northeast is the Nooksack River, but these features are separated from the planning area by developed lands, particularly in the Samish Valley.

It is feasible that the Lake Whatcom watershed is part of a movement or travel corridor for far-ranging species such as deer, elk, cougar, bear, and birds. However, there is no specifically identified *migration corridor* of which it is a part. The watershed does provide a unique opportunity for contiguous low-elevation mature forest that may be a "stepping-stone" (habitat linkage) between Mount Baker and the Chuckanut Range for far-ranging species that can travel through forested state and private lands, and agricultural/rural lands. It should be kept in mind that all of these potential travel ways are surrounded by development.

Within the Lake Whatcom planning area itself, there are some contiguous blocks of "mature" forest (defined in this context as at least 60 years old). These are located primarily in the middle-western portion (Lookout Mountain), southwestern portion (small amount of unroaded forest), and middle-eastern and northeastern portions (largest block of contiguous mature forest) of the planning area.

There appear to be few unique or special habitats (such as wetlands, cliffs, talus, caves, or balds) within the planning area, according to orthophoto interpretation and local knowledge. More complete information on the locations of such habitats can only be acquired through field inspections, which is beyond the scope of this assessment. Such habitats would be protected under all of the proposed alternatives, based on the HCP, and would be identified during project-level reconnaissance.

There is a unique stand of old bigleaf maple trees with an understory of western redcedar and Douglas-fir in the northwestern portion of the landscape. This stand likely provides moderate to high wildlife value.

Fish

Species Present
Since the early 1900s the following native and non-native fish species have been documented in Lake Whatcom (Dominguez, 1997):

Native:	cutthroat trout (*Oncorhynchus clarki clarki*)
	kokanee (*Oncorhynchus nerka*) – non-anadromous sockeye salmon
	peamouth (*Mylocheilus caurinus*)
	cottid (*Cottus* ssp.)
Non-native:	brook trout *(Salvelinus fontinalis)*
	lake trout *(Salvelinus namaycush)*
	yellow perch *(Perca favescens)*
	brown bullhead *(Ictalurus nebulosus)*
	largemouth bass *(Micropterus salmoides)*
	smallmouth bass *(Micropterus dolomieui)*
	other trout sub-species (Beardslee, Yellowstone black-spotted cutthroat (Tokul Creek, Kamloops)

This analysis mainly summarizes the habitat needs of the native cutthroat and kokanee, with the assumption that the riverine habitat needs of other fishes are included. The term "salmonids" is used to refer to the taxonomic family salmonidae, of which both the cutthroat and kokanee are members. For additional details please see the PDEIS, pages 118 – 130.

Fish Life Histories

Cutthroat
The native cutthroat are resident (non-anadromous) and are common throughout the Lake Whatcom Planning Area. Their distribution can be limited by extremely steep gradients and high waterfalls; however, some populations exist in isolation above waterfalls (Dominguez 1997, PDEIS Appendix F (F-7)). Native cutthroat spawn and/or rear in all Type 3 streams in the Lake Whatcom drainage. The resident cutthroat likely have persisted from post-glacially isolated sea-run cutthroat populations.

Cutthroat spawning generally occurs from December to mid-June and occurs in several Lake Whatcom tributaries, including Carpenter Creek, Smith Creek, Anderson Creek, Brannian Creek, Beaver Creek and the Squalicum Interbasin. In general, resident cutthroat have been found to make short movements to spawning areas (Likness and Graham 1988; Varley and Gresswell

1988), and are know to spawn within a variable range of gravel particle sizes (Hunter 1973; Thurow and King 1994; Quinn and Associates, unpublished data). Because these fish are relatively small, spawning generally occurs in small sized gravel particles (<1 inch diameter gravel and sand).

Cutthroat may spend significant portions of or their entire lives in a very small stream area or even a particular pool They use logjams, upturned roots and accumulations of large woody debris (LWD) as winter habitat. They also are very dependent on channel stability, low flow refuge and lateral habitat and cover for rearing. In the confined, higher gradient tributaries, resident fish may not be able to maintain positions in rearing areas during excessive bedload and debris movements (Dominguez, Watershed Analysis 1997).

Austin and Beaver creeks – and to a lesser degree Carpenter, Olson and Smith creeks – are the most important cutthroat producing tributaries of the Lake Whatcom drainage. There are minimal areas of spawnable-sized gravel, and siltation of those areas is a common occurrence in most of the tributaries. Characterizing percent fine sediment from visual observation in the gravel- and cobble-dominated reaches likely underestimates the impacts that a heavily–armored substrate could have on spawning salmonids. Some segments used for spawning in Olson, Carpenter, Beaver and Austin creeks are compacted to the degree that increased fine sediment is readily transported through because the gravels and cobble are already compacted with fines (Dominguez, Watershed Analysis 1997).

Cutthroat redds, however, are susceptible to intrusion of fines in these areas after redd construction has occurred (redd construction cleans gravel, creating interstitial spaces). Spawning areas are also subject to scour, and spawning resident populations may be affected mostly due to the lack of spawning gravel retention in headwater streams. A main contributing factor for cutthroat's persistence is their extensive distribution throughout the watershed.

Subsurface flows affect the summer rearing habitat of cutthroat. These flows occur in Carpenter Creek, several downstream portions of Blue Canyon tributaries, Fir Creek, Brannian Creek, Beaver Creek, Squalicum Interbasin and several small tributaries draining into Lake Whatcom. Subsurface flows may be the natural condition of these streams because of steep terrain and shallow bedrock which limit~~s~~ water impoundment. Excessive sedimentation in many streams contributes to the low flows and subsurface flows. Beaver dams in Brannian Creek and Squalicum Interbasin provide positive benefits of prolonged surface slows through the summer and help regulate high streamflow periods in the winter. Cutthroat are generally resilient to the short-term impacts of main-channel degradation because they are able to seek out rearing and spawning habitat in small tributaries. The long-term trend for cutthroat when winter habitat is reduced may be a reduction in stream productivity or reduction in presence of older trout year-classes (Hall et al. 1987; Cederholm, unpublished data; Dominguez, Watershed Analysis 1997).

Kokanee
The kokanee of Lake Whatcom likely persisted from anadromous sockeye populations that had been historically deprived of ocean access due to Whatcom Falls (Ricker 1940; Groot and Margolis 1991). Like the anadromous form of sockeye, kokanee require a lake in their life history, and generally the lake is used for juvenile rearing and growth and the tributaries for spawning (Dominguez 1997, Appendix F (F-5)).

Information on natural production of kokanee in the Lake Whatcom Planning Area is scarce, other than a few periodic spawner surveys in the mid-1970s and other anecdotal information. Significant spawning populations have been observed in Brannian, Olson, Fir and Anderson creeks, and to a lesser extent in Carpenter, Smith and the lower portions of several unnamed creeks. Shoreline spawning can occur near South Bay Hatchery, especially after a flood event displaced kokanee that have migrated into the lower portion of Brannian Creek (Dominguez 1997, Appendix F). Lake Whatcom kokanee spawn from late August through January (historically through February), with the majority of spawning from late October through early December (Looff 1994). Most spawn in their third year (2+) although there may be some in their second and fourth years (1+ and 3+).

Upon emergence from the intragravel environment in late January through March, kokanee fry generally migrate to Lake Whatcom within a few days. In the juvenile stage they inhabit shoreline areas and feed largely on plankton, supplementing their diets with copepods, cladocera and insects (Dominguez, Watershed Analysis 1997). Kokanee generally stay in schools during adult life and may migrate around the lake about 100 yards off shore.

Lake Whatcom kokanee are smaller than average when compared to other Pacific Northwest kokanee. Data (Rieman and Myers, 1992) suggest that kokanee growth is strongly influenced by lake productivity. Lake Whatcom generally maintains low phosphorous, total phosphorous, and nitrogen levels. The lake's nutrients (mainly phosphorus) may be absorbed and precipitated by fine particulates.

Most of the observed segments of natural kokanee spawning habitat in Smith Creek, Fir Creek and South Bay Interbasin either exhibited excessive fines or a high level of compaction. Small-bodied salmon generally cannot effectively mobilize severely compacted gravels. The degree of compaction affects the ease of digging, and salmon may avoid highly compacted areas altogether (Dominguez, Watershed Analysis 1997).

Fish Migration

Adult cutthroat and kokanee must reach spawning grounds at the proper time and with sufficient energy reserves to complete their life cycles. Waterfalls, road culverts, debris jams and excessive water velocities may impede migrating fish. Waterfalls that are insurmountable at one time of the year may be passed at other times when flows have changed. Fish migrating upstream must have suitable stream flows, water temperature, velocities and depths that provide for successful staging (rest) and passage (Bjornn and Reiser 1991). Kokanee and cutthroat generally have limited jumping and swimming ability due to their small bodies.

Culvert passage problems which affect cutthroat habitat are present in the North Shore, Blue Canyon, South Bay and Geneva interbasins. Stream gradient generally increases rapidly beyond these culverts). Riprap from the old railroad crossing in Anderson Creek has been described as "difficult passage" for kokanee spawner migration. (Dominguez, Watershed Analysis 1997).

Kokanee migration problems associated with low stream flows are exacerbated by alluvial aggradation on several larger streams (Carpenter, Olson, Smith and Brannian) as well as segments of Blue Canyon and South Bay interbasins. Observations at the Brannian Creek

Hatchery indicate that kokanee will leave staging areas at the creek mouth and go to other streams to spawn if flows are not adequate (Harvard, pers. comm.). Attempts to swim up rivulets with no cover are hampered by avian predator encounters and dead end shallow pools with no cover.

Several segments within the watershed have been diked or leveed. These artificial constraints have greatly altered the natural sediment transport and disturbance processes that originally formed these channels. Entrenchment of lower Austin Creek, for example, has resulted in a channel with a much coarser bed than expected due to an increase in sediment transport capacity created by the constructed banks and large woody debris removal practice. These constraints have also eliminated potential for formation of side-channel habitat and recruitment of wood via bank erosion or channel shifting.

Fish Habitat

For additional information on the specific fish habitats of Lake Whatcom and its tributaries, beyond what is provided below, see the Final Report of Forest Practices and Their Effect on Water Resources in the Lake Whatcom Watershed: A Review of Existing Information, prepared by Jeff Grizzel, Forest Hydrologist, Washington Department of Natural Resources (PDEIS Appendix D). For trends in stream channel disturbance in the Lake Whatcom drainage, see descriptions in the Channel Module Lake Whatcom Watershed Analysis (WADNR 1997).

General Riparian Influences

The riparian ecosystem is where aquatic and terrestrial habitats interact (Cederholm 1994). From shoreline to uplands, there exists a continuum of physical and biological processes that contribute to productive salmonid habitats. The riparian ecosystem can be modeled as three unique zones: the aquatic zone, riparian zone and a zone of direct influence (Naiman et al. 1992). The aquatic zone is the location of aquatic environments, including the complete channel migration zone, where water may be present during any time of the year. This zone is often referred to as the 100-year flood plain. Adjacent to the aquatic zone is the riparian zone, a narrow band of moist soils and distinctive wetland vegetation. Uplands lie beyond the riparian zone. The spatial extent of upland influences on aquatic ecosystems delineates the direct influence zone. The health of the aquatic zone is positively influenced by the terrestrial areas within the riparian and upland direct influence zones (Cederholm 1994). Salmonids inhabit the aquatic zone, but their habitat encompasses the entire watershed.

General Freshwater Habitat

All freshwater life stages of salmonids require several major habitat factors. These include access to habitats; moderate stream flows; cool, clean well oxygenated water; low levels of silt within spawning gravels; low suspended-sediment load; adequate food supply; and relatively stable stream channels formed by frequent accumulations of large woody debris.

Each salmonid life stage has slightly different critical habitat requirements, and lack of suitable habitat for a single life stage could affect the viability of an entire stock. Eggs incubating in a redd require a high concentration of dissolved oxygen, which is a function of variables including water temperature, biological oxygen demand, stream flow and sediment load. High biological oxygen demand, caused by microbial decomposition of organic materials, can decrease the amount of fresh oxygenated water moving through the redd (Bjorn and Reiser 1991). Fine sediments settle into the spaces between gravel and can impede the flow of water to the eggs (Everest et al. 1987). Excessively high streamflows and associated streambed scour can destroy redds and the incubating eggs and alevins that they contain (Schuett-Hames 1996).

Alevins reside in the redd, where they need clean, cool, well-oxygenated water for incubation. Heavy sediment loads can negatively affect alevins by blocking the emergence of fry and entombing them within the gravel environment.

Fry and parr depend on good water quality, abundant food supply, cover and living space. Water temperatures affect the rate of growth and development, as all cold-water fish cease growth at temperatures above 68.5 degrees Farenheit (Reiser and Bjornn 1979). The preferred temperature range of all salmonids is between 50 and 57 degrees Farenheit and the upper lethal temperature limit lies between 73.4 and 78.4 degrees Farenheit (Reiser and Bjornn 1979).

High loads of suspended sediment may abrade and clog salmonid gills (Noggle 1978; Reiser and Bjornn 1979). Too much fine sediment (material that is sand sized and smaller) deposited on the streambed may negatively affect juveniles by destroying their food supply (Reiser and Bjornn 1979).

Stream productivity and riparian vegetation are two factors that affect the density of insects and other aquatic macroinvertebrates, the principal prey of juvenile salmonids. The amount of detritus present in a stream is an important variable affecting stream productivity (Bjornn and Reiser 1991). High stream productivity leads to high densities of herbivorous aquatic insects. Terrestrial insects enter streams by falling or being blown off riparian vegetation; this input has been found to be an important component of the prey base of juvenile salmonids.

Stream dwelling salmonids benefit from habitat complexity. Stream habitat complexity relates to a high diversity in the size, location and variety of physical, hydrological and biological elements. Among the elements that contribute to stream complexity are a variety of gravel sizes, pools of various depths, riffles, eddies, side channels, undercut embankments, boulders, aquatic vegetation, and amount of cover in the form of large woody debris.

Factors Influencing Fish Habitat

Water temperature

Water temperature is principally a function of vegetative cover. Over-stream vegetation moderates energy flow into and out of aquatic ecosystems. Removing riparian vegetation and the shade it provides raises summer water temperatures. It also allows heat to escape in winter, lowering winter water temperatures. The degree to which water temperature is affected by riparian vegetation is a function of stream size. For example, the temperature of shallow water bodies responds more quickly to changes in air temperature, and the temperature of small streams is more sensitive to changes in riparian vegetation because the forest canopy covers a higher proportion of the stream's surface (Chamberlin et al. 1991). Other factors that can influence stream temperature are: groundwater input (seeps, springs), variations in streamflow, geometry of the vegetative cover (e.g., buffer width and height), cumulative effects of upstream riparian disturbances, stream orientation, and the synergistic effects of these factors.

Coarse Sediment
Riparian buffers can intercept sediments flowing from uphill disturbances. Sediments are delivered naturally from uplands to riparian ecosystems primarily through landslides and road surface runoff (Reid 1981; Reid and Dunne). Landslide events rapidly add large quantities of material to the stream network. In undisturbed watersheds, the concentration of sediments increases substantially during storms and much of this increase is the direct result of soil mass-wasting (landslides) (Swanston 1991).

Roads in upland areas can have significant detrimental impacts on salmonid habitat. In few locations can roads be built that have no negative effects on streams (Furniss et al. 1991). In the Pacific Northwest, logging roads appear to contribute more to landslides than clearcutting, although this association varies substantially with location (Sidle et al. 1985), and seems to be highly dependent on watershed hydrology and geomorphology (Duncan and Ward 1985).

Fine Sediment
Sources of fine sediment are numerous within the basin, with the greatest transport occurring in Austin and Smith subbasins. Hydrologic Simulation Program Fortran (HSPF) modeling results based on 11 streams feeding Lake Whatcom suggest that Smith and Austin creeks, while accounting for only 37 percent of total flow, accounted for 93 percent of the suspended sediment load (suspended solids), most of which was associated with a few large storm events (Walker et al. 1992). Common features likely responsible for the high loads are: the occurrence of landslide-prone slopes directly adjacent to streams, the lack of storage capacity due to continuously steep gradients and tight confinement, and extensive scour following the 1983 event which left numerous exposed surfaces available for chronic surface erosion.

A sediment budget for Smith Creek (Gacek and Assoc. 1990) suggests that landslides are the largest source of sediment and that this material is largely fine textured (70 percent is <11.2 mm.). Considering the extremely large quantities delivered to the channels during the 1983 event and the current scarcity in most segments, fine sediment must be largely transported out of these subbasins. Additionally, quick attrition of Chuckanut Formation sandstone and siltstone to fines with the mainstem of Austin Creek has also been observed (Mary Raines, pers. comm.). Over a distance of 450 meters downstream, mean particle size of fine-grained siltstone, sandstone and mudstone decreased by 50 percent and number of fine-grained rocks that broke easily by hand decreased by 48 percent. While far from conclusive, these findings suggest that inputs of gravels and fines into most Chuckanut Formation drainages have quick breakdown rates and are readily transported into low gradient reaches near the lake or entirely out of the subbasin.

In contrast to Smith and Austin creeks, Olsen Creek seems to have chronic fine sediment inputs. While scarce deep pools prevent the accumulation of deep deposits, surface and interstitial fine sediment was observed around most flow obstructions. The scour or burial of many channel roughness elements (primarily LWD) needed to direct/focus stream energy following the 1983 event has resulted in limited sorting of channel sediments and a more random distribution of fine sediment. The absence of LWD and high availability of sediment is also characteristic of Carpenter, Fir and Anderson creeks. Large quantities of fine sediment are also being imported into Lake Whatcom via Anderson Creek and the Middle Fork of the Nooksack water diversion.

Nutrients

The amount of small organic debris accumulations (detritus) affects stream productivity (Bjornn and Reiser 1991). High stream productivity is characterized by high densities of herbivorous aquatic macroinvertebrates. In forested headwater streams, riparian vegetation is the primary source of detritus (Gregory et al. 1987; Richardson 1992). Removal of vegetation along these streams will lessen this input and can negatively affect the long-term productivity of downstream areas.

Stand age and canopy cover significantly influence detrital input to a stream system. Old growth forests contribute approximately five times more detritus to streams as clearcut forests (Bilby and Bisson 1992). Richardson (1992) found that old growth forests contributed approximately double the detritus as either 30-year-old or 60-year-old forests. However, even though streamside timber harvest reduces detrital input, the resulting reduction in forest canopy can lead to increased light levels and consequent algal production in the aquatic zone, which in turn produces a short-term pulse of autotrophic productivity (Bilby and Bisson 1992). Streamside harvest is allowed along Type 5 waters under the HCP.

Erman et al. (1977) found that the composition of invertebrate communities in streams with riparian buffers wider than 100 feet was indistinguishable from those of unlogged streams. From this result, FEMAT (1993) inferred that riparian buffers at least 100 feet wide delivered sufficient small organic material to maintain a diverse aquatic community.

Large Woody Debris

Large woody debris recruitment mechanisms into channels consist largely of mass wasting events and windthrow on steep adjacent valley walls. The extreme steepness of many of the walls likely facilitates transport of windthrown trees into the channel from distances greater than their tree height. Infrequent transport of LWD through steep gradient reaches may also be important for fan channels. Where gradients are less and catastrophic disturbance is rare, bank failure and channel migration are important. These processes are frequently restricted by riprap and constructed levees or dikes.

The input of large woody debris (woody material at least 10 cm. in diameter and 2 m. long) from the riparian corridor is the most important link between terrestrial and aquatic ecosystems, acting on stream flows to create essential elements of salmonid habitat – deep pools, riffles, side channels, and undercut embankments (Swanston 1991; Maser et al. 1988) Large woody debris causes lateral migration of the stream channel, creating backwaters along stream margins and increasing variations in depth (Maser et al. 1988). Large woody debris serves as cover for fish from predators and competitors and moderates the energy of stream flows, thereby decreasing streambed scour and bank erosion. Log jams perform at least four main functions:

1. They store fine sediments in Type 4 and 5 streams that would adversely affect downstream spawning areas and invertebrate populations;
2. They retard the flow of nutrients down the channel, thus increasing stream productivity;
3. They retain gravel of various sizes essential to salmon spawning;
4. They create turbulence that scours deep pools, important to rearing older age-class trout and salmon.

During floods, LWD in the riparian zone is important for the maintenance and development of riparian soils. It moderates the energy of stream flows, stabilizes soils and traps suspended sediments and organic nutrients. Saturated soils of riparian zones may impede the regeneration of conifer species. Large woody debris, however, can enhance conifer regeneration by acting as nurse trees for seedlings by providing appropriate moisture conditions and advantages in light competition.

Through stream bank erosion, windthrow, tree mortality and beaver activity (Bisson et al. 1987), the riparian zone supplies nearly all the LWD. The probability that a fallen tree will enter a stream is a function of distance from the channel and tree height (Van Sickle and Gregory 1990).

Measurements of LWD input to streams in western Washington and Oregon indicate that in old growth conifer forests riparian buffers 120 feet wide would be 90 percent effective in delivering LWD to aquatic ecosystems. In terms of tree height, McDade et al. (1990) showed that 90 percent of the potential LWD lies within a zone whose width is approximately 60 percent of the height of the average tree in the riparian ecosystem.

Instream stability and longevity of LWD are assumed to be important for its ecosystem function. Stability is a function of size, with debris length relative to stream width having the greatest effect. Instream longevity of LWD is a function of both size and species of wood; larger pieces are more resistant to breakage, and conifers are more resistant to fragmentation and decomposition than red alder (Bisson et al. 1987), a hardwood often associated with riparian areas.

Fish habitat and channel analysis indicated a widespread lack of functioning LWD in most segments within the Lake Whatcom watershed. Several factors are likely contributing to this condition:

- The 1983 storm resulted in flushing of both sediment and LWD from many channels and local deposition/accumulations were generally removed to promote more efficient water conveyance.
- Current riparian stands are dominated largely by 30-40 foot tall alder. Potential recruitment of large conifers in the near term is extremely low.
- Removal and/or conversion of riparian vegetation associated with residential developments, road construction, agriculture, a golf course, and debris torrent scour of adjacent bedrock walls has jeopardized both near- and long-term recruitment of LWD, particularly large conifers.
- LWD along mainstem reaches of Smith Creek is monitored. Pieces which could potentially block streams and have material collect behind them have been cut into smaller lengths to reduce the risk of logjams forming and causing potential hazards to downstream residences and resources.

Wind Buffers

Riparian buffers need to maintain characteristics of stability and longevity to promote long-term function (Steinblums et al. 1984; FEMAT 1993). Windthrow resulting from near-stream harvests may compromise the intended function of the riparian management zone. A single windstorm could raze entire sections of the riparian buffer, or successive high wind events may, over longer periods, slowly degrade the integrity of the riparian ecosystem. Windthrow is vital to riparian ecosystems in natural forests – a significant proportion of all instream large woody debris is blowdown (Murphy and Koski 1989; McDade et al. 1990). However, abrupt forest edges commonly occurring between riparian buffers and clearcuts can cause more frequent catastrophic windthrow events and accelerated blowdown rates. The purpose of the wind buffer under DNR's HCP is to increase the stability and longevity of the riparian buffer, i.e., to maintain its ecological integrity.

ENERGY AND NATURAL RESOURCES

Energy Resources (Coal, Oil, Gas, Hydropower)

Oil, gas and coal are the potential energy resources within the landscape planning area. The state holds the mineral rights for most of the trust land in the planning area, however, mineral rights are partially or wholly held by other parties in certain parcels. DNR does not control the mineral development in parcels where it does not own the mineral rights. Hydropower potential is very limited in the planning area.

Coal

Coal deposits are present within geologic formations that underlie much of the planning area. Past coal production occurred from at least four underground mines located at various locations within the planning area. Several coal seams ranging from four to 15 feet of good quality coal were exploited in these mines. None of these mines occurred on DNR-managed land.

Coal reserves have been estimated in past reports indicating that additional reserves of coal are present in the planning area. Little drill testing is reported to support these potential reserves and the extent, quality, and thickness are not known. The presence of coal resources under State-managed land is uncertain, but potential exists for coal resources within these lands. It is uncertain whether any coal deposits here would be of economic interest in the future. Energy demand may make these deposits attractive at some point, but currently there is little interest.

There are no active coal leases on state trust land in the planning area, but coal option contracts were granted on state trust lands in the past. Leasing of the state-managed lands for coal exploration and development is at the discretion of DNR, or at the discretion of the mineral owner, as the case may be.

Oil and Gas

Natural gas potential is present within the landscape planning area. A number of gas occurrences have been noted in the Bellingham-Lake Whatcom areas in past oil and gas test wells. Two test wells completed in the planning area tested positive for gas. Methane gas is often associated with coal deposits, which is the case here. Coal-bed methane deposits are targets of current interest in gas exploration in other areas in Puget Sound.

There has been some oil and gas activity on state land at various times in the past. There is currently one active oil and gas lease on state trust land within the landscape planning area. This lease expires in 2006 and has a no surface occupancy (disturbance) condition. Future interest in oil and gas leasing in the landscape planning area is expected.

Mineral Resources (Sand, Gravel, Rock, Metals)

Sand, Gravel and Rock

High quality sand, gravel or rock deposits for use as construction aggregate material are limited within the landscape planning area. Glacial outwash deposits, which often produce good quality construction material, are present in the lowland between Squalicum Mountain and Stewart Mountain. Several small gravel pits have been developed here for local use in road construction and maintenance. The Washington State Department of Transportation (WSDOT) has developed other small pits in glacial material near South Bay for the same use. There are no commercial pits on State land within the planning area and limited potential for commercial development.

DNR has extracted rock and gravel from State land for forest road construction and maintenance. This material is from small borrow pits, generally less than one acre in size. New pits of this nature would be constructed in compliance with all HCP and Forest Practices rule requirements.

Metallic Minerals

There are no known or reported metallic mineral deposits or occurrences in or near the planning area. The geologic setting in the management area is not favorable for the formation of these types of deposits.

Industrial Minerals

Glacial clay deposits have been exploited in the general management area for tile and brick use and are noted in drill tests near DNR-managed trust land. Clay deposits have not been developed on trust land within the planning area and it is unlikely future development will occur because of limited demand for this material.

Forest Resources (Timber, Special Forest Products)

Timber Resources

Information about existing timber resources comes from the department's Forest Resource Inventory System (FRIS). Inventory was conducted on lands within the planning area in 1995. More than 80 percent of the stands are of commercial size in the medium and large saw timber size classes. See the PDEIS under Affected Environment (page 134) for percentage of the Planning Area by size class and by species.

Current state law requires the department to manage state forestlands to produce a sustainable, even-flow harvest of timber, subject to economic, environmental, and regulatory considerations (Forest Resource Plan Policy Number 4). The department implements this policy by setting harvest levels over a 10-year period. The anticipated minimum rotation age for regeneration harvests on westside stands is 60 years; however, to meet specific objectives, the department may cuts stands as young as 45 years old or stands older by several decades.

For commercial harvests the department uses regeneration harvests, intermediate pole harvests, small wood thinnings, and partial cuts. The most common harvest method used in the project area has been regeneration clearcuts, a system that removes all of the volume in an existing commercial timber stand during harvest with the exception of reserve trees and snags left under green tree retention. Intermediate harvests of cedar and Douglas-fir poles are practiced where specific site and stand conditions are met.

The focus of commercial thinnings is maintenance of a high growth rate in stands by manipulation of stocking levels and without reduction of the total value of the stand over the expected rotation. The emphasis of a late thinning or partial cut is the intermediate removal of volume from stands without compromising the commercial characteristics of the residual stands.

Factors significant to successful commercial timber harvests include suitable and reasonable access to sites, sufficient quantities of wood to support economically viable harvest operations, and timber of suitable size and quality. A related and important impact to harvestability is the choice of logging method. Cable and ground based systems are the most commonly used with ground based yarding limited to slopes less than 30 percent. Helicopter yarding is utilized where road access is unavailable. The practicality of using helicopters is primarily a function of flight distance and elevation between the logging unit and log landing area; yarding distances beyond ¾-mile downhill or ¼-mile uphill make use of helicopters unfeasible.

Special Forest Products

Special forest products are forest products other than timber that are harvested for a variety of personal and commercial uses such as edibles, floral products, Christmas greens, and pharmaceutical extracts, e.g., Cascara bark, Pacific yew, St. Johns wort.

Elements critical to the success of management, harvesting and marketing of commercial special forest products are:

- access to remove a commercial volume of a product in an economically feasible manner,
- quantity to support an economically viable harvest operation, and
- quality products to meet commercial standards.

Other related factors include harvest site in relation to slope, product density, distance to market and road conditions, exclusive vs. non-exclusive harvest sites, and disease and insect damage.

See the PDEIS (pages 135-136) for discussion of economically important forest products specific to the project area. Additional comment on mushrooms can be found in the PDEIS Comments and Responses for Affected Environment (page 38).

Carbon Sequestration

This section should be read in conjunction with information in DEIS Appendix D: Comparison of three landscape management alternatives for Lake Whatcom, with specific reference to potential revenues from carbon sequestration, forest product certification, and recreation. In the context of this DEIS, carbon sequestration refers to the net flow of carbon out of (or into) the atmosphere. The term forest “carbon sequestration,” also called “carbon offset,” refers to a forest’s ability to store carbon and counterbalance carbon dioxide emissions. Forests draw carbon dioxide out of the atmosphere through the process of photosynthesis.

Through the process of carbon sequestration, actively growing forests can offset atmospheric carbon emissions from other sources, sources often associated with human activities. Carbon thus sequestered may have financial value in offsetting these atmospheric emissions of carbon through regulatory and other mechanisms, constituting a potential (emerging) revenue source for land management activities. This section assesses prospects in the Lake Whatcom landscape for carbon sequestration under the three proposed management alternatives, recognizing that:

- The Lake Whatcom landscape is small relative to other forested tracts, thus the carbon sequestration opportunity offered in the Lake Whatcom watershed is likely to be small relative to other forested tracts.
- The original old-growth forest on most of the Lake Whatcom landscape has been replaced by re-growth forest (PDEIS, Table 8, page 108; 2002). Carbon sequestration prospects are reported to improve significantly in re-growth forest compared with conversion of old growth forest, even when decomposition processes are taken into account (Harmon et al., 1990; Cohen et al., 1996).
- The department has little ability to influence off-site carbon storage

In general, forests sequester carbon and reduce carbon emissions in four ways: 1) carbon is stored in the forest (stems, foliage, litter, roots, soil), 2) in products produced from the forest, 3) through biomass conversion to energy uses, displacing the use of fossil fuel and 4) through product substitution for fossil-intensive products (Bowyer et al., 2002). Forest carbon is increased through afforestation from non-forest uses of the land. Forest carbon increases with age as the trees grow until harvest or natural disturbances occur. Natural mortality or disturbance and decomposition limit the amount of carbon that can be stored in the forest. Harvesting for long-lived products on the other hand, increases the carbon stored in products from one rotation to the next if the product life is greater than the rotation length. Wood used in buildings lasts longer than a forest rotation, while other uses may not. Therefore the sum of forest and (long-lived) products carbon is not stable but increases over time as the inventory of product in buildings increases. To the extent that short-lived product enters landfills, the amount of long-term carbon accumulation depends upon the decomposition rate. However, if the short-lived product and processing residuals are burned for their energy values (co-generation), the energy produced can permanently displace fossil fuels much like long-lived products, albeit storing less carbon because of the relatively low boiler efficiency for wet wood. Lastly, any deferral or reduction in harvesting results in the substitution of fossil-fuel intensive products for wood products, increasing net carbon emissions.

As a consequence, long-rotation management or other harvest deferrals result in non-wood substitution corresponding to the period of reduced harvest, thus storing less carbon in total than short-rotation management, even though there will likely be more carbon stored in the forest. In contrast, short-rotation intensive management accelerates the time availability of wood and the amount, decreasing non-wood substitution. The management alternatives in the Lake Whatcom landscape involve progressively lengthening rotations and progressively increasing areas of deferred harvest or permanent removal of forest from the land base potentially available for harvest. Therefore the alternatives under consideration in the DEIS likely become increasingly less favorable (from the No Action Alternative to the Preferred Alternative to Alternative 3) in terms of aggregate net carbon storage, even though the amount of stored forest carbon may increase.

In summary, while afforestation and intensive (sustainable) forest management can increase or maintain the amount of carbon stored in the forest and products, harvest set asides and/or longer rotations can have the opposite impact. Forests that are left to decompose whether over time or by fire represent lost opportunities to capture the product storage and energy value of wood, resulting in increased use of fossil-fuel intensive products. Intensively managed forests store more carbon in products more quickly than less intensively managed forests, and are thus responsive to an objective of increasing carbon storage as an offset to the consumption of fossil fuels.

Scenic Resources/Viewsheds
Scenic views tend to be limited by forest canopies. Views generally occur with isolated outcroppings or in areas where roads, harvesting or amenities create openings in the canopy.

Potential scenic views of Bellingham and the watershed exist on Lookout Mountain and Stewart Mountain, and there are potential scenic lake and mountain views from the North Shore trail. Currently, road access to and across DNR-managed land is gated, and the quality of existing roads does not meet public travel needs. In addition, the points have not been managed to maintain views.

Built Environment

ENVIRONMENTAL HEALTH

Release of toxics/hazardous materials
Road access to and across state land is gated, reducing the risk of abandoned vehicles, garbage, and oil and other fluid spills. Communication site lessees and logging contractors do use the gated road system, which could leak minor amounts of oil and fluids.

Methamphetamine labs are becoming increasingly common in forested areas easily accessible from adjacent urban areas. However, no incidents have been reported on state trust lands in the planning area.

Risk of Explosion and Fires
The risk of explosion in the planning area is very limited, though local concerns were heightened by the June 1998 Olympic Pipeline incident nearby. The comprehensive plan map of natural gas and oil transmission and natural gas distribution routes shows natural gas distribution lines to customers at the north end of the Lake Whatcom watershed. Oil transmission lines are located beyond the planning area's west boundary.

Risk of Slides, Floods, Debris Flows
Stream systems that drain steep topography within the planning area are susceptible to debris torrents that alter channels and form alluvial fans. Slope failures and significant debris flows have been part of the evolving landscape since deglaciation, independent of timber harvest and the presence of roads, and they will continue to occur. Natural events present a continuing threat of property damage and danger to people occupying the channels and alluvial fans of these drainages.

LAND & SHORELINE USE

Existing Land Use Plans / Growth Estimates
The Whatcom County Comprehensive Plan sets the land use vision and goals for all but the small southern portion of the Lake Whatcom planning area which extends into Skagit County.

Some land in the northwest part, including Bellingham neighborhoods abutting the lake, is within the urban growth boundary. But most of the planning area, including all state trust lands, is outside the urban growth boundary and subject to lower population densities and more rural land uses.

The comprehensive plan states that typical uses in rural areas "include a mixture of low-density residential, pasture, agriculture, woodlots, home occupations, and cottage industries. The distribution of rural land use is adjacent to agricultural, forestry, and urban land uses and often provides a buffer between urban areas and commercial agriculture and forestry uses." (Whatcom County Comprehensive Plan, 1997)

Land use designations in force in the Lake Whatcom watershed include commercial forestry, rural forestry, mineral lands, rural, suburban enclave and public/recreation. County development regulations outline permitted uses for each of these designations. The county has designated most of the DNR-managed property as commercial forestland of long-term significance.

Whatcom County's population was recorded at 166,814 in the 2000 federal census, up from 127,780 in 1990. The projected population for 2015 is 220,366 people, based on an assumption of a two percent average annual increase, based on the state Office of Financial Management's high projection for the county. Actual growth has consistently exceeded OFM projections and was pegged at 3.26 percent from 2001 to 2002. Whatcom County had the eighth highest growth rate of Washington counties for that period.

Residential and Commercial Development

In the Whatcom County portion of the watershed approximately 70 percent of the land is zoned commercial and rural forestry; 13 percent is zoned residential and 16 percent, rural. Assessor data from 1999 showed residential use occurring on 10.3 percent of the land within the planning area and commercial development or uses on 0.8 percent.

There is no residential development on state trust lands in the planning area and commercial development is limited to three communication sites.

Bellingham city neighborhoods within the watershed include the Alabama Hill and Silver Beach planning areas, and to a lesser extent the Whatcom Falls and Mt. Baker neighborhood planning areas. Land use primarily is allocated for single and multi-family housing, with limited areas of commercial and public zoning. Three county areas are also zoned urban residential: Sudden valley, the Geneva Urban Growth Area and the County Fringe Urban Growth Area.

Allowable residential development densities vary, with minimum lot size and maximum density for new construction dependent on the availability of public sewer and water service. Under current zoning the densities range from a maximum of 12 units to the acre in areas with urban services down to one dwelling unit per 40-acre parcel in the rural forestry zone.

Potential Future Growth

No residential development is expected on state trust lands due to current zoning.

Because of "concerns that future and current development within the Lake Whatcom Watershed will degrade the quality of water that is withdrawn from the lake for drinking water purposes" the Whatcom County Council has temporarily downzoned development in a number of areas within the watershed. An interim zoning ordinance (WWC Ordinance #2002-036) was passed on June 18, 2002 for a six-month period, with the possibility of one or more six-month extensions. A similar ordinance (WCC Ordinance #2003-031) imposing an interim zoning map for the watershed for a six-month period was adopted on May 6, 2003, with provisions for six-month extensions.

Aesthetics
The "visibility" of forestry operations is influenced by factors including the position and distance of the viewpoint from the activity, the topography of the land, the type of operation and the intensity and/or concentration of activities. The observer's personal values and background influences whether the reaction to the visual impact is negative or positive, as does what is revealed or hidden as a result of the activity, and how long the activity is in view.

State trust lands are visible from a number of locations throughout the watershed, including homes, Bloedel Donovan Park and the North Shore Trail, the Sudden Valley golf course, the lake, county roads, city roads and forest roads. (Visual Impacts Assessment, 2001)

Local residents see these viewsheds most frequently and for the longest intervals. Residences are concentrated in the Northshore, Southbay, Sudden Valley, Bloedel, Smith Creek, Geneva, and Cain/Reed areas. When topography, distance and other land features are considered, general areas of state trust lands can be identified as having "moderate" or "high" visibility from these residential areas. (See PDEIS Map S-1.)

Recreation
Current recreational use is informal and dispersed. Typical activities are hiking, hunting, mountain biking, horseback riding, mushroom and berry picking. There are no developed camping facilities or DNR-managed trails on state trust lands within the planning area.

Hiking: The 1,200 mile Pacific Northwest Trail, running from the Continental Divide to the Pacific Ocean, crosses the southernmost end of the planning area. This trail passes through the Rocky Mountains, Selkirk Mountains, Pasayten Wilderness, North Cascades, Olympics and the wilderness coast. The trail crosses three national parks and seven national forests. A trail map on an Internet website shows the trail passing through DNR-managed land but no formal sanction or easement has been issued.

Hikers also have access to three miles of lakeshore via the North Shore Trail (See PDEIS Map R-1). Sudden Valley has a small network of trails within the development's boundaries. The trails are generally within greenbelts and connect park areas, and a small volunteer trail maintenance program being formed by Sudden Valley recreation staff has generated some interest. Some trails link to DNR-managed roads south of Sudden Valley ownership. Residents of Sudden Valley walk on these roads. No trails (sanctioned or unsanctioned) are known to exist on adjacent DNR lands.

Mountain biking: Mountain biking activity within the planning area has increased dramatically within the past few years and will likely continue to increase. A local mountain-biking club has been very active in construction and maintenance of a trail system on Galbraith Mountain in the western part of the landscape. Most of the trail system is on private lands with a little use on state trust lands near the Galbraith Mountain communication site. The trail system's capacity has been stretched for a number of reasons. These include increasing popularity of the sport, easy access for a nearby population, exposure in national publications, and recently enacted restrictions or bans on mountain biking in other areas, such as USDA Forest Service wilderness, DNR-managed Natural Resource Conservation Areas, national and state parks. Increasing motorcycle use of the area has resulted in some conflicts.

The pressures will likely result in mountain bikers looking to expand the existing trail systems or create new systems in other areas. Access to private and public lands for mountain biking varies greatly depending on ownership and landowner objectives for their land.

Equestrian use: Horseback riding is popular on state lands on Stewart Mountain, though the trail system is unsanctioned. Members of the Whatcom Backcountry Horse-riders Association actively use and maintain this trail system. In 2000 Whatcom County Parks constructed a horseback riders trailhead facility off Y Road, which is used to access trust lands north of Lake Whatcom. Equestrians use existing logging roads and abandoned roads as well as trails. Use of roads is year-round while trails are generally used during summer months when soils are not as saturated.

Off-road vehicle use: Off-road vehicle (ORV) use has been discouraged because it increases the potential for resource damage in watersheds where water quality is critical Damage to forest roads from ORV use can be costly to repair. The primary method of discouraging use is personal contact with and environmental education of ORV operators. Gates block access to major forest road systems, in cooperation with other major landowners and local governments. When necessary, enforcement action is taken to protect public resources and trust assets.

Historic and Cultural Preservation

There is considerable evidence that the Lake Whatcom watershed has prehistoric, historic, ethnographic and current use areas of interest. The majority of the prehistoric and historic materials are probably near the lakeshore. However, inland prehistoric and historic properties as well as current use areas occur in historical records and in tribal records and will be found in the planning area.

A partial listing of known cultural resource types in the Lake Whatcom watershed is presented in the PDEIS (page 144). These cultural resources include archaeological and historical sites as well as cultural resources of concern identified by the Lummi Nation. The Nooksack Tribe did not participate in this identification process. Not all of these cultural resource types are known to exist on state trust lands.

Traditional named places, legendary sites, ritual bathing sites and spirit quest sites are known as Traditional Cultural Properties (TCP). These sites or localities are important in maintaining the culture of a group or tribe. They are not mutually exclusive: for example a legendary site may also have been used for gathering medicinal herbs and may also show ancient manifestations of that gathering, and therefore may be an archaeological site.

Many of these sites are related to past, present and future Native American spirituality and religious practices, which were and are the most intensely personal and private matters imaginable among many Native American groups. Therefore, there is understandable reluctance to share the locations of these sites and information on activities occurring there. This tension between a land manager's need for specificity and tribal members' secrecy needs makes protection of the resource extremely difficult.

Known cultural resources are either recorded or unrecorded. The Lummi Nation and Nooksack Indian Tribe maintain an extensive listing of cultural resource properties within ceded lands and usual and accustomed areas. Tribal policy is to not share this information. Since these sites are not listed on the Washington State Inventory of Historic Places, they are considered not recorded for state land management purposes.

Recorded sites, if they have been evaluated, are documented as significant or not significant. It is assumed additional cultural resources exist in the landscape but are unknown. Though an historic property can be of intense significance to an individual or small group, for the purpose of this discussion (and in cultural resource management generally) sites are considered "significant" only if they are included on the National Register of Historic Places (NRHP), are eligible to be on the NRHP, or are potentially eligible. Although state and local registers exist, the NRHP is the standard in cultural resource management. Only "significant" properties are protected under state and federal law. No cultural resource in the planning area has been evaluated for NRHP inclusion.

See DEIS Appendix D for additional details of cultural resource properties categories and PDEIS Appendix D for the prehistory and history of the planning area.

The cultural resource data gaps in the planning area are enormous. The major gap is the lack of information from the Nooksack Tribe. The Lummi Nation's data cannot be considered exhaustive because individual tribal members may choose not to identify sites to the tribal government or to an outside entity.

The lack of prehistoric and historic sites in the watershed is not surprising. Only one small cultural resource survey has been completed within the planning area boundaries. There is no information on underwater archaeological sites.

Agriculture
Significant agricultural use is not anticipated since all of the lands designated for long-term agriculture in the Whatcom County Comprehensive Plan lie outside the planning area. However, agriculture is a permitted use for land within the planning area zoned rural residential. The Skagit County lands at the southern tip of the planning area are designated for forestry use.

Silviculture
The department implements a range of silvicultural practices including natural and artificial reforestation, chemical and mechanical site preparation, vegetation control, fertilization, pruning,

precommercial and commercial thinnings, partial cuts, and regeneration harvests. Non-commercial activities are those that may alter the biological composition of a stand but will not involve commercial commodity production or removal from the site. See the PDEIS Affected Environment 4.1.2.2. (Pages 146-147) for details of silviculture practices specific to the planning area.

TRANSPORTATION

Transportation Systems (Forest Roads, Trail Systems)

There are currently 44 miles of active forest roads and 42 miles of orphaned roads on DNR ownership in the planning area. Orphaned roads are roads or railroad grades that have not been used for forest practices activities after 1974. Many of these roads are overgrown or closed off, but have not satisfied the abandonment process.

The road density of active roads is 1.8 miles per square mile. These roads are sufficient for conventional harvest of about 25 percent of the planning area. Road density is provided for comparison in this document only. Other geographic areas will have different ideal road densities, due to different terrain or concentration of environmentally sensitive features.

Pages 147-149 of the PDEIS contain additional discussion of transportation issues in this planning area.

Forest Road Maintenance and Abandonment Plans

Washington law (WAC 222-24-051) requires that forest landowners assess all active and orphaned roads on their lands by 2005. All active roads must meet current legal standards by 2015. As road systems are assessed, landowners submit a plan for accomplishing the maintenance and abandonment work. This plan is referred to in the Forest Practices rules as a Road Maintenance and Abandonment Plan (RMAP).

Locally, DNR completes RMAPs in three stages: initial assessment, prescription, and implementation. Initial assessment includes an aerial photo search for orphaned grades and driving or walking all active and orphaned roads to find problems. The prescription phase develops a specific plan for maintenance work. This occurs shortly before the equipment moves in to perform the implementation phase. The majority of RMAP repair work is done by DNR crews.

Traffic Patterns

Roads on DNR-managed land often continue onto private ownership. Neighboring landowners may also contribute to traffic on DNR-managed roads. Legal easements govern the use of these shared roads.

Traffic generally consists of trucks hauling logs and rock. Roads that access communication sites or other utilities may be frequently used for maintenance of those facilities.

The forest road network joins with public streets at many points. Trucks that leave DNR lands via North Shore Drive or Y Road would travel north to the Mount Baker Highway and either head west to I-5 or east, depending on their destination. Trucks using Turkington Road, Park

Road, and DNR mainlines on the hills above Park Road eventually intersect with Highway 9 and head north into Whatcom County or south through Sedro Woolley. Trucks entering Lake Louise Road typically travel to I-5 via Lakeway or north past Bloedel Donovan Park to Britton Road. Some traffic from Lake Louise Road may go east on Lake Whatcom Boulevard, but a bridge with weight restrictions limits loads on this route. On the very south end of the planning area, timber may be hauled to the Skaarup Road and continue either west to I-5 or east to Highway 9.

Traffic using these routes may travel through populated areas of Whatcom County, including North Shore, Acme, Geneva, Sudden Valley, Cain Lake/Glenhaven, and Alger communities. Several of the routes pass through one or more school zones. The level of traffic on a particular road varies, depending on where forest management activity is occurring. This traffic is also seasonal in nature, with more truck trips occurring during drier weather.

Other public roads that may be affected include: Camp 2 Road, Manley Road, Squires Lake Road, and access to the Whatcom County rifle range. These areas have had little timber haul from DNR lands in the past but could experience increased traffic, depending on the harvest level and road construction options that are chosen.

Due to the poor supply of durable rock nearby, rock for road construction is hauled from pits in the Whatcom or Skagit County lowlands, Lummi Island, or nearby foothills.

Water, Rail and Air Traffic

DNR management of its lands within the Lake Whatcom watershed, regardless of the alternative selected, will not have a significant impact on water, rail or air traffic. Products will be transported by truck and no railroad lines pass through the planning area. Helicopter logging will be considered in harvest planning, with minimal effects on air traffic.

PUBLIC SERVICES & UTILITIES

Relation to Trust Income

State trust lands in the Lake Whatcom landscape generate revenues for seven different trusts, based on timber harvest and other commercial activities carried out on the acreages displayed in Table 1**.** These revenues are then distributed to beneficiaries using ratios specified in Washington state laws. Action by the Board of Natural Resources (BNR) may change the total amounts distributed to the beneficiaries; the discretionary authority of the BNR is also specified in law.

The revenue distribution ratios shown in Table 9 below apportion shares of the revenues to the state general fund, trust beneficiary accounts, junior taxing districts, and land management accounts. They were derived by multiplying the share of the land base managed for each trust in the Lake Whatcom landscape planning unit by the ratios referred to in the preceding paragraph. Since the revenue distribution ratios are ultimately based on specific locations, they will not provide precise revenue impacts by trust in any one decade (e.g., some trusts may have a disproportionate share of the harvestable land base in any particular time period). However, the ratios are useful for estimating average revenue impacts by trust for the entire planning period.

Table 9: State trust land distribution in the Lake Whatcom landscape, and the proportions of the land base contributing revenue to associated beneficiary groups

Beneficiary Entity	Area in Acres	Proportion of Total Area	Revenue Distribution Ratios
Whatcom County Forest Board Transfer	8,423	53.8%	
Bellingham & Mt. Baker School Districts			15.6%
Bonds			5.1%
Maintenance and Operations			10.5%
Whatcom County Roads			7.3%
Whatcom County			5.1%
Library			1.7%
Port of Bellingham			1.3%
Whatcom County Conservation Futures			0.2%
State General Fund			10.8%
DNR Forestry Development Account (FDA)			11.8%
Whatcom County Forest Board Purchased	690	4.4%	
Bellingham & Mt. Baker School Districts			0.8%
Bonds			0.3%
Maintenance and Operations			0.6%
Whatcom County Roads			0.4%
Whatcom County			0.3%
Library			0.1%
Port of Bellingham			0.1%
Whatcom County Conservation Futures			0.0%
State General Fund			0.6%
DNR Forestry Development Account (FDA)			2.2%
Skagit County Forest Board Transfer	881	5.6%	
Burlington-Edison School District			1.8%
Bonds			0.8%
Maintenance and Operations			0.9%
Skagit County Roads			0.7%
Skagit County			0.6%
United General Hospital			0.2%
Port of Skagit			0.1%
Skagit County Medic 1			0.1%
Skagit County Conservation Futures			0.0%
State General Fund			1.0%
DNR Forestry Development Account (FDA)			1.2%
Common School	4,627	29.6%	
Common School (K-12)			22.2%
DNR Resource Management Cost Account (RMCA)			7.4%
Agricultural School (WSU)	193	1.2%	
Agricultural School (WSU)			1.2%
DNR Resource Management Cost Account (RMCA)			0.0%
Capitol Buildings	286	1.8%	
Capitol Buildings			1.4%
DNR Resource Management Cost Account (RMCA)			0.4%
Scientific School (WSU)	557	3.6%	
Scientific School (WSU)			2.7%
DNR Resource Management Cost Account (RMCA)			0.9%
Total	15,657	100%	

Notes: Trusts in bold typeface, beneficiary groups in regular typeface. Totals may not add due to rounding.

Fire
Fire protection is provided on improved property by four Whatcom County fire districts: No.2, Geneva/Sudden Valley; No.4, Bellingham; No. 10, Bellingham; and No. 18, South Lake Whatcom. These districts also provide emergency medical response.

DNR provides fire protection to state and private forestland. In the event of large wildland fires multi-agency teams of local, state and federal partners cooperate in firefighting efforts.

Police
The Bellingham Police Department provides police protection and services to all areas within the Bellingham city limits, including neighborhoods at the northwest corner of the planning area. The Whatcom County Sheriff's jurisdiction covers all county lands within the planning area. The Sheriff's patrol boat provides protection and handles incidents that occur on Lake Whatcom. The Skagit County Sheriff is responsible for the small southern portion of the planning area within Skagit County.

Schools
Bellingham School District No. 501 and Mt. Baker School District No. 507 serve students in or near the Lake Whatcom watershed. The following Bellingham schools are located within the planning area: Silver Beach, Geneva and Northern Heights elementary schools and Squalicum High School. Mt. Baker students who live in the Cain Lake area are transported through the planning area to Acme Elementary School and Mt. Baker Junior High School/Mt. Baker Senior High School in Deming.

Parks and Recreation Facilities
DNR-managed land in the planning area offers no developed recreation facilities, formal camp sites or formal hiking trails. However, adjacent to state trust lands there are parks and recreation facilities that serve the surrounding community. These include Bloedel-Donovan Park, Whatcom Falls Park, the Northshore trail and public access to Lake Whatcom. See the PDEIS (page 151) for additional details.

Communications
Three DNR communication sites are located west of Lake Whatcom in the planning area. These are identified, from north to south, as Galbraith Mountain, Lookout Mountain and South Lookout. (See PDEIS Appendix C, Map P-1).

Water/Storm Water Management
The principal public facilities associated with water or storm water management that could potentially be affected by trust land management includes bridges and the stream water intake for the Brannian Creek fish hatchery. The Lake Whatcom watershed analysis (DNR, 1997a) assigned a low vulnerability rating to all the bridges for peak flows. The water intake for the fish hatchery, however, received a high vulnerability rating for peak flows. Because trust lands are only a small part of the Brannian Creek watershed, it is unlikely that their management will have a significant effect on peak flows.

Sewer/solid waste management
Since most DNR-managed lands in the planning area are designated for commercial forest use there had been no need for sewer or wastewater planning. Solid waste management has been limited to cleanup of unauthorized garbage dumping because there is no residential use of the lands.

No Action Alternative

Natural Environment

EARTH
Approximately 11,390 acres of the 15,707 acres of trust land in the planning area would be available for timber harvesting under the No Action Alternative. In addition, there are approximately 3,098 acres mapped as unstable areas (Watershed Analysis ARSs 1, 2, 3 and 4) where harvesting would be either prohibited or significantly restricted. There would be approximately 1,181 acres of riparian buffer and 38 acres of wind buffer. No large areas have been identified as possibly inaccessible for harvesting under this alternative.

About 62 miles of new road would be constructed during the next 60 years. Approximately 1.7 miles of construction would be on slopes mapped as unstable and one mile on potentially unstable slopes. An average of 89 acres of regeneration harvests, 47 acres of thinning, and 11 acres of partial-cut harvests would occur annually.

Unstable Slopes
Short-term: Direct Impacts – Indirect Impacts
Road construction could destabilize local slopes and result in impacts to stream channels (Sidle et al., 1985; Montgomery, 1994; Wemple et al., 2001). Removal of support from steep, unstable slopes and potentially unstable slopes as a result of road construction could cause small debris slides or debris flows. These failures could block the road, damage the road prism, destabilize slopes above the road cut-banks, or plug drainage structures causing water to be diverted onto the road surface, road fill-slopes, or stream channels. If failed debris enters a steep stream channel, a debris torrent could result. Sediment and debris entrained in debris torrents would likely reach fish habitat and, possibly, public facilities and private structures. The likelihood for the potential impacts described above to occur would be substantially mitigated by adherence to Watershed Analysis Prescriptions. The Prescriptions prohibit road construction on the steeper and most slope stability-sensitive areas, and they specify construction practices designed to prevent slope failures that could significantly impact water quality, fish habitat or public facilities.

No probable significant impacts to slope stability would be expected as a result of implementing the No Action Alternative. Road construction and timber harvesting must comply with Watershed Analysis Prescriptions that were designed to prevent slope failures that could create significant impacts. Additionally, a DNR slope stability specialist will make an on-site evaluation of activities on potentially unstable slopes. Timber harvesting could affect slope stability by influencing root structure and the amount of water that enters the soil (Sidle et al. 1985). The potential effects of these influences on slope stability have been modeled using numerous timber harvest and site condition scenarios (Sidle, 1992; Krogstad, 1995; Schmidt et